SLOVENSKI STANDARD
SIST EN 50343:2003

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Železniške naprave – Vozna sredstva – Pravila za inštaliranje kablov

Railway applications - Rolling stock - Rules for installation of cabling

Bahnanwendungen - Fahrzeuge - Regeln für die Installation von elektrischen Leitungen

Applications ferroviaires - Matériel roulant - Règles d'installation du câblage

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45.060.01	Železniška vozila na splošno	Railway rolling stock in general

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English version

Railway applications -
Rolling stock -
Rules for installation of cabling

Applications ferroviaires -
Matériel roulant -
Règles d'installation du câblage

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Regeln für die Installation von elektrischen Leitungen

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CENELEC

European Committee for Electrotechnical Standardization
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Foreword

This European Standard has been prepared by the Working Group B8 of SC 9XB "Electromechanical material on board of rolling stock" of the Technical Committee CENELEC TC 9X, Electrical and electronic applications for railways. As the subjects „Cabling“ and „Cables“ have much in common, a close co-operation between the above Working Group and Working Group 12 „Railway cables“ of CENELEC TC 20 „Electric cables“ has been maintained during preparation.

The text of the draft was submitted to the formal vote and was approved by CENELEC as EN 50343 on 2002-12-03.

The following dates were fixed:

- latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2003-12-01

- latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 2005-12-01

Annexes designated "normative" are part of the body of the standard.
Annexes designated "informative" are given for information only.
In this standard, Annexes A, C, D, E, H and J are normative and Annexes B, F, G, and I are informative.

Contents

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1 Scope

This European Standard specifies requirements for the installation of cabling on railway vehicles and within electrical enclosures on railway vehicles, including magnetic levitation trains and trolley buses.

NOTE With respect to trolley buses, this standard applies to the whole electric traction system, including current collecting circuits, power converters and the respective control circuits. The installation of other circuits is covered by street vehicle standards for example those for combustion driven buses.

This standard covers cabling for making electrical connections between items of electrical equipment, including cables, busbars, terminals and plug/socket devices. It does not cover special effect conductors like fibre optic cables or hollow conductors (waveguides).

The material selection criteria given here are applicable to cables with a copper conductor.

This standard is not applicable to the following:

- special purpose vehicles, such as track-laying machines, ballast cleaners and personnel carriers;
- vehicles used for entertainment on fairgrounds;
- vehicles used in mining;
- electric cars;
- funicular railways.

As the field of cabling in rolling stock is also dealt with in the cable makers' standard, references are made to EN 50264, EN 50306 and EN 50355.

This European Standard applies in conjunction with the relevant product and installation standards. Stricter requirements than those given in this standard may be necessary.

2 Normative references

This European Standard incorporates by dated or undated references, provisions from other publications. These normative references are cited at the appropriate place in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

EN 45545-1 [1)]	Railway applications - Fire protection on railway vehicles - Part 1: General
EN 45545-5 [1)]	Railway applications - Fire protection on railway vehicles - Part 5: Fire safety requirements for electrical equipment including that of trolley buses, track guided buses and magnetic levitation vehicles
EN 50121-3-1	Railway applications - Electromagnetic compatibility - Part 3-1: Rolling stock - Train and complete vehicle
EN 50121-3-2	Railway applications - Electromagnetic compatibility - Part 3-2: Rolling stock - Apparatus
EN 50124-1	Railway applications - Insulation coordination - Part 1: Basic requirements - Clearances and creepage distances for all electrical and electronic equipment
EN 50125-1	Railway applications - Environmental conditions for equipment - Part 1: Equipment on board rolling stock
EN 50153	Railway applications - Rolling stock - Protective provisions relating to electrical hazards
EN 50200	Method of test for resistance to fire of unprotected small cables for use in emergency circuits

[1)] At draft stage.

EN 50215	Railway applications - Testing of rolling stock after completion of construction and before entry into service
EN 50264-1	Railway applications - Railway rolling stock cables having special fire performance - Standard wall - Part 1: General requirements
EN 50264-2	Railway applications - Railway rolling stock cables having special fire performance - Standard wall - Part 2: Single core cables
EN 50264-3	Railway applications - Railway rolling stock cables having special fire performance - Standard wall - Part 3: Multicore cables
EN 50306-1	Railway applications - Railway rolling stock cables having special fire performance - Thin wall - Part 1: General requirements
EN 50306-2	Railway applications - Railway rolling stock cables having special fire performance - Thin wall - Part 2: Single core cables
EN 50306-3	Railway applications - Railway rolling stock cables having special fire performance - Thin wall - Part 3: Single core and multicore cables (Pairs, triples and quads) screened and thin wall sheathed
EN 50306-4	Railway applications - Railway rolling stock cables having special fire performance - Thin wall - Part 4: Multicore and multipair cables standard wall sheathed
EN 50355 [1]	Railway applications - Railway rolling stock cables having special fire performance - Thin wall and Standard Wall - Guide to use
EN 60352-1	Solderless connections - Part 1: Wrapped connections - General requirements, test methods and practical guidance (IEC 60352-1)
EN 60352-7	Solderless connections - Part 7: Spring-clamp connections - General requirements, test methods and practical guidance (IEC 60352-7)
EN 60684-3-212	Flexible insulating sleeving - Part 3: Specifications for individual types of sleeving - Sheet 212: Heat-shrinkable polyolefin sleeving, flame retarded, shrink ratio 2:1 (IEC 60684-3-212)
EN 60684-3-216 [1]	Flexible insulating sleeving - Part 3: Specifications for individual types of sleeving - Sheet 216: Heat-shrinkable, flame retarded, limited fire-hazard sleeving (IEC 60684-3-216)
EN 60684-3-217	Flexible insulating sleeving. Part 3: Specifications for individual types of sleeving - Sheet 217: Heat-shrinkable polyolefin sleeving, flame retarded shrink ratio 3:1 (IEC 60684-3-217)
EN 60684-3-271	Flexible insulating sleeving - Part 3: Specifications for individual types of sleeving - Sheet 271: Heat-shrinkable elastomer sleeving, flame retarded, fluid resistant, shrink ratio 2:1 (IEC 60684-3-271)
EN 60947-7-1	Low-voltage switchgear and controlgear - Part 7-1: Ancillary equipment - Terminal blocks for copper conductors (IEC 60947-7-1)
EN 60947-7-2	Low-voltage switchgear and controlgear - Part 7-2: Ancillary equipment - Protective conductor terminal blocks for copper conductor (IEC 60947-7-2)
EN 60998-2-2	Connecting devices for low-voltage circuits for household and similar purposes - Part 2-2: Particular requirements for connecting devices as separate entities with screwless-type clamping units (IEC 60998-2-2)
EN 60999-2 [1]	Connecting devices - Electrical copper conductors - Safety requirements for screw-type and screwless-type clamping units - Part 2: Particular requirements for clamping units for conductors above 35 mm² up to 300 mm² (included) (IEC 60999-2)
EN 61210	Connecting devices - Flat quick-connect terminations for electrical copper conductors - Safety requirements (IEC 61210, modified)
EN 61310-1	Safety of machinery - Indication, marking and actuation - Part 1: Requirements for visual, auditory and tactile signals (IEC 61310-1)
HD 383 S2	Conductors of insulated cables – First supplement: Guide to the dimensional limits of circular conductors (IEC 60228:1978 + IEC 60228A:1982, modified)

HD 384.4.43 S2	Electrical installations of buildings -- Part 4: Protection for safety -- Chapter 43: Protection against overcurrent (IEC 60364-6-43:1977 + A1:1997, modified)
HD 384.5.54 S1	Electrical installations of buildings - Part 5: Selection and erection of electrical equipment - Chapter 54: Earthing arrangements and protective conductors (IEC 60364-5-54:1980, modified)
HD 588.1 S1	High-voltage test techniques - Part 1: General definitions and test requirements (IEC 60060-1:1989 + corrigendum March 1990)
IEC 60050-461	International Electrotechnical Vocabulary - Chapter 461: Electric cables
ISO 1302	Geometrical Product Specifications (GPS) – Indication of surface texture in technical product documentation

3 Definitions

For the purposes of this standard, the following definitions apply. Reference is made to IEC 60050-461.

3.1
cable
assembly consisting of

- one or more cores (screened or unscreened),
- their individual covering(s) (if any),
- assembly protection (if any),
- screen(s) (if any),
- sheath (if any)

[461-06-01, mod.]

3.2
conductor (of a cable)
part of a cable which has the specific function of carrying current

[461-01-01]

3.3
core
assembly comprising a conductor with its own insulation (and screens if any)

[461-04-04]

3.4
solid conductor
conductor consisting of a single wire

[461-01-06, mod.]

3.5
stranded conductor
conductor consisting of a number of individual wires or strands all or some of which generally have a helical form

[461-01-07, mod.]

3.6
busbar
conductor consisting of a rigid metal profile

3.7
screen (of a cable)
conducting layer(s) having the function of control of the electro magnetic field within the cable and/or to protect the cable from external electro magnetic influences

[461-03-01, mod.]

3.8
bundle
group of cables tied together

3.9
bolted connection
connection in which the pressure to the conductor is applied by bolting

[461-19-05]

3.10
crimp
cable termination in which a permanent connection is made by applying pressure, inducing the deformation or reshaping of a barrel part of the termination around the conductor

[461-19-01, mod.]

3.11
spring-clamp connection
terminal connection in which the pressure between the conductor and terminal is applied by a spring

3.12
penetration (connection)
terminal connection in which the contact with the conductor is achieved by jaws which penetrate the insulation

3.13
plug
connector intended to be coupled at the free end of an insulated conductor or cable, to be inserted into a matching socket, or readily removed when required

3.14
socket
connector intended to be mounted on a rigid surface and to hold a matching plug, such that the conductors contained within the socket make electrical contact individually with those in the plug

3.15
heat-shrinkable sleeve
plastic tube that on exposure to heat during installation, will at a critical temperature, permanently reduce in diameter, while increasing in wall thickness

3.16
manufacturer
organisation that has the responsibility for the supply of vehicle(s), equipment or groups of equipment to the purchaser

3.17
purchaser
organisation that orders the vehicle or equipment or groups of equipment and has the responsibility for direct negotiations with the manufacturer

4 Abbreviations

EMC Electromagnetic compatibility

5 Technical requirements

5.1 General requirements

Cables and installation materials shall be type tested, selected for size and installed so as to be suitable for their function under their operating conditions. Size and installation of cables (or busbars) shall take into account the particular stresses to be expected in rolling stock. The materials used and methods of cabling shall be such as to prevent strain or chafing and excessive lengths of unsupported cable shall be avoided.

Cables on rolling stock shall not be used for any purpose other than for transmission, distribution and collection of electrical energy, electrical controls or monitoring systems. All components of cabling shall be selected, installed, protected, used and maintained so as to prevent danger (e.g. electrical or fire hazard, EMC problems).

The electrical connections shall be made in such a way that they can not be unintentionally disconnected or interrupted during service by thermal effects, dynamic loads as shock, vibration, car body motions, etc. that are to be expected.

Where ambient conditions are considered, EN 50125-1 shall apply.

For protection against electrical hazard, the cabling installed shall be in accordance with EN 50153.

5.2 Selection of type and size of cables

5.2.1 General

When selecting cables or busbars the expected operating conditions should be taken into account. These should include but are not limited to the following parameters:

- voltage;
- current;
- overload current;
- voltage drop;
- short circuit current;
- shape and frequency of current;
- fusing characteristic of the protection device;
- grouping of cables;
- ambient temperature and temperature due to load current;
- methods of installation;
- predicted cable lifetime;
- presence of rain or steam or snow or accumulation of condensing water;
- presence of corrosive, polluting or damaging substances;
- mechanical stresses;
- radiation such as sunlight.

Consideration should be given to the expected lifetime of the cabling compared with the expected lifetime of the vehicle.

The cable type (i.e. cable family) shall be selected in accordance with EN 50264 or EN 50306 etc, as applicable.

Once the cable type has been selected, the selection of conductor size when the cable is intended for power distribution shall be based on either load current and current carrying capacity calculated in accordance with 5.2.3, or based on protection device size in accordance with 5.2.4.

Short circuit conditions should additionally be checked according to HD 384.4.43 S2. Recommended short circuit ratings for rolling stock cables are given in EN 50355. Short circuit conditions and overload conditions should be checked with respect to the fusing characteristic of the protection device and the resistance of the chosen cable. See example in Figure 1.

NOTE 1 This short circuit or overload case should be checked according to
Normal load < nominal switching level of protection device < current carrying capacity of the cable (I_{corr} , see definition in 5.2.3 b)).

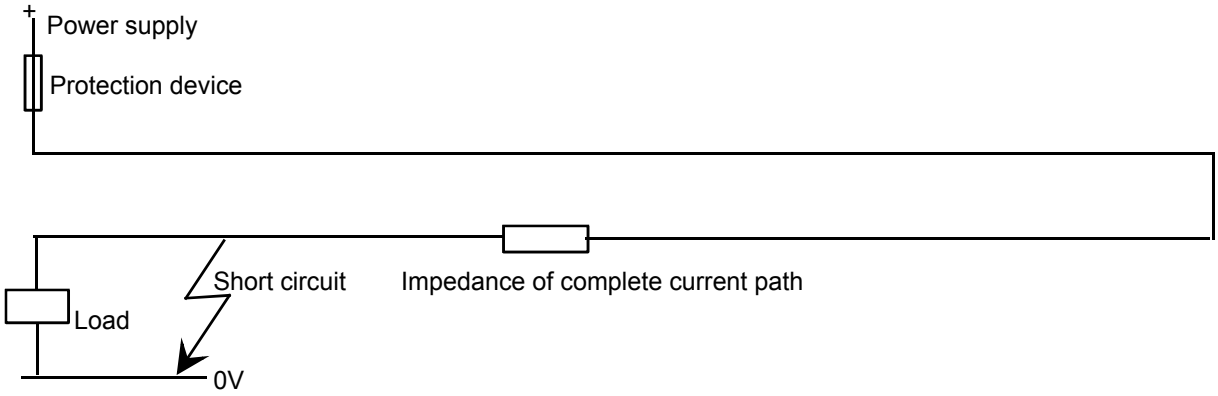

Figure 1 – Example of short circuit condition where cable size will have influence on protection device behaviour

The cross-sectional area of any conductor shall be not less than the value specified in 5.5.

Only cabling which conforms to the fire safety requirements specified in Clause 6 of EN 45545-1 and EN 45545-5 shall be used.

NOTE 2 The number of different types of cables installed on any one type of vehicle should be minimized for practical reasons.

5.2.2 Selection of cable size for control cables

Control cables, which are intended to carry control signals only, shall have a minimum conductor cross-sectional area as specified in 5.5. This is also valid if the load current would make a smaller cross-sectional area possible.

NOTE It is not necessary for the conductor size of these cables to be selected according to 5.2.3.

5.2.3 Selection of cable size for cables for power distribution, on the basis of load current

This subclause specifies a method for calculation of continuous maximum load current of different cable sizes dependent on their method of installation and ambient temperature, to enable cables to be selected so as to ensure that the predicted lifetime is achieved.

The continuous maximum conductor temperature for the cable types defined in the various parts of EN 50264 and EN 50306 is either 90 °C or 105 °C. This is based either on proven experience and reliability over many years or in the case of newer, less well defined, insulations upon an acceptance test, using long-term thermal endurance ageing to demonstrate a lifetime of at least 20 000 h at 110 °C and 125 °C respectively (i.e. 20 °C above the continuous rating). Data from this thermal testing can, with care, be extrapolated to the conductor temperature to provide a predicted lifetime of the cable when continuously loaded. This predicted lifetime may be used in conjunction with the known duty cycle of the vehicle, and its predicted time out of service, to estimate the ability of the cable to function reliably for the predicted lifetime of the whole vehicle.

NOTE 1 Because the cable standards allow a variety of solutions for insulation type, it is important to confirm lifetime extrapolations with the cable manufacturer.

NOTE 2 A predicted lifetime of cable of 100 000 h may be used as a theoretical basis value.

NOTE 3 This subclause only deals with thermal degradation of insulation material and it should be noted that mechanical stresses (wear, etc.) and other environmental factors (such as presence of fluids such as cleaning detergents, aggressive atmosphere) may be the limiting factor determining predicted cable lifetime.

For cables intended for power distribution, the cable size shall be selected on the basis of the load current and the current carrying capacity in accordance with the following procedure (i.e. the three steps a), b) and c)).

a) The load current

The load current I_{load}, in amperes (A) which a cable has to carry for sustained periods during normal service shall be a basic value for cable sizing.

When the circuit(s) being supplied by the cable is in continuous or sustained cyclic operation, I_{load} shall be calculated according to the following equation:

$$I_{load} = \sqrt{\frac{1}{t_1}\int i^2 \, dt}$$

where

t_1 is the duration of a typical duty cycle during service, in minutes (min)
i is the instantaneous current – including overload, if any - in amperes (A).

NOTE 4 For continuous direct current operation, the above equation has the simple form $I_{load} = i$.

When operation is not continuous or sustained cyclic, I_{load} shall be calculated according to Annex A.

b) The current carrying capacity

The permissible continuous current carrying capacity I_{cable} in amperes (A) of a single-core cable being operated in free air shall be another basic value for cable sizing. A particular value of I_{cable} is valid for a particular reference ambient temperature T_{ref} and for a particular maximum conductor temperature in service, $T_{c(max)}$.

The values I_{cable}, T_{ref} and $T_{c(max)}$ to be used, shall be those provided by the cable manufacturer, however, some examples are presented in Annex B.

I_{cable} for maximum conductor temperatures other than $T_{c(max)}$ = 90 °C, shall be calculated according to Annex C.

The current carrying capacity of the cable in service, I_{corr}, in amperes (A) shall be calculated from I_{cable} using correction factors to take into account the expected ambient temperature, the installation type, etc., in accordance with the following equation.

$$I_{corr} = I_{cable} \times k_1 \times k_2 \times k_3 \times k_4$$

where

k_1 is a correction factor for the expected ambient temperature. It shall be calculated according to the following formula:

$$k_1 = \sqrt{\frac{T_{c(max)} - T}{T_{c(max)} - T_{ref}}}$$

where

$T_{c(max)}$ is the maximum conductor temperature, in degrees Celsius (°C), in service, which will allow the predicted lifetime of the cable to be achieved.

T is the estimated value of the actual ambient temperature, in degrees Celsius (°C) during operation, on the outside of the bundle or of the tube - if any. T is an average value.

T_{ref} is the reference ambient temperature, in degrees Celsius (°C), for which the I_{cable} value is valid.